Reusable Composite Structures

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Content

- Demolition of existing structures
- Traditional and demountable shear connectors
- Demountable composite flooring systems
- On-going experiments
- Outlook

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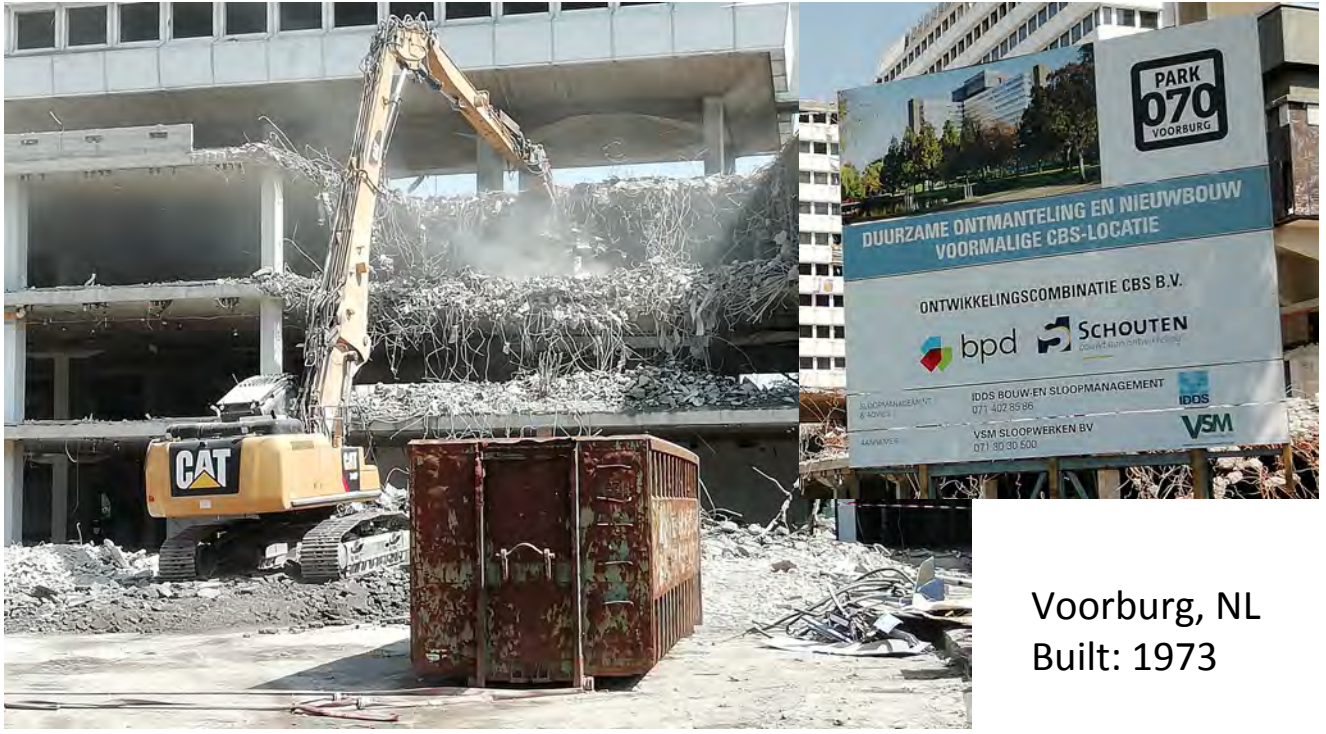
“Sustainable” demolition – CBS Building



Voorburg, NL
Built: 1973

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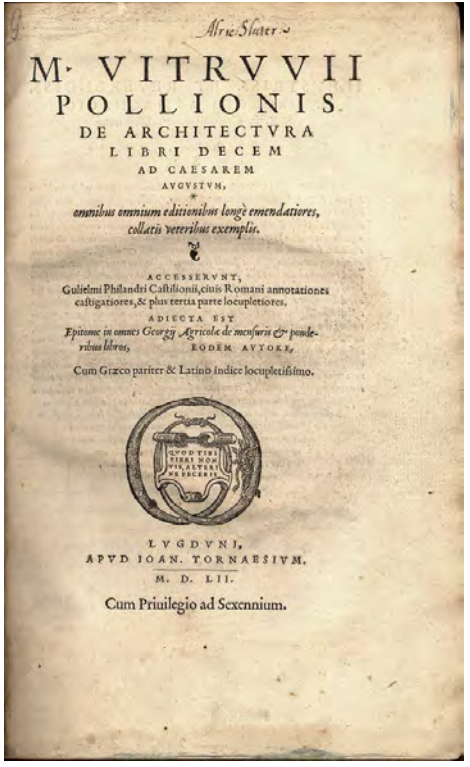
Demolition – Hub Synergy Point

Singapore, SG
Built: 1973

Obsolescence – the reason for demolition

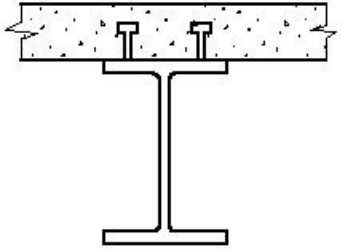
- Technical - *firmitas*
- Aesthetical - *venustas*
- Functional - *utilitas*

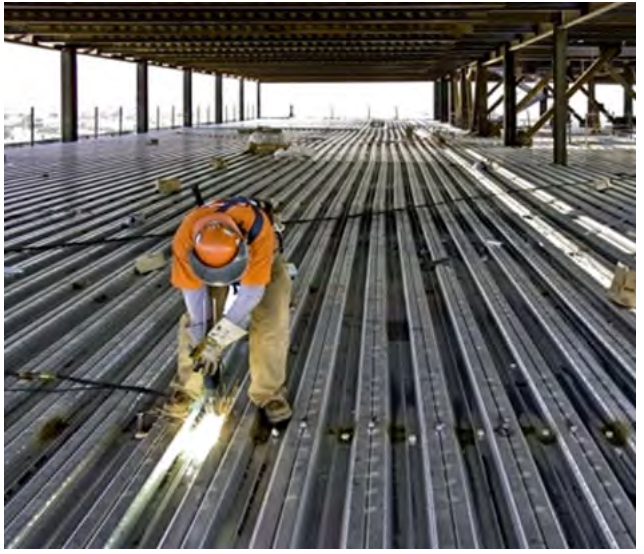
- Social
- Economical
- Logistical


M· VITRVVII
POLLIONIS
DE ARCHITECTVRA
LIBRI DECEM
AD CAESAREM
AVGVSTVM,
omnibus omnium editionibus longè emendatiores,
collatis veteribus exemplis.
ACCESSERVNT,
Gulielmi Philandri Castilionii, ciuis Romani annotationes castigatiores, & plus tertia parte locupletiores.
ADIECTA EST
Epitome in omnes Georgij Agricolæ de mensuris & ponderibus libros, EODEM AVTORE.
Cum Græco pariter & Latino indice locupletissimo.
LVGDVNI,
APVD IOAN. TORNAESIVM.
M. D. LII.
Cum Priuilegio ad Sexennium.

Traditional shear connector

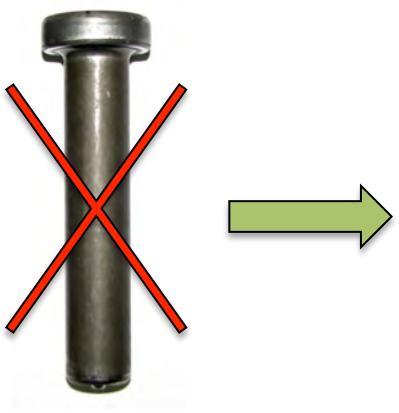
- Cast in-situ deck





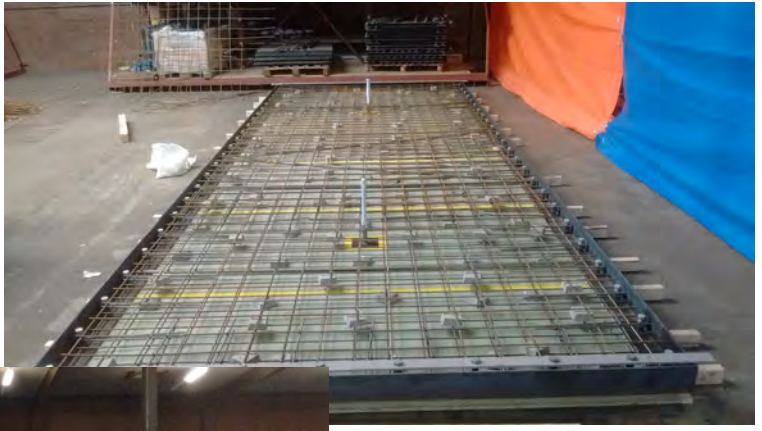
Demountable shear connectors

- Cast in-situ deck
- Prefabricated deck



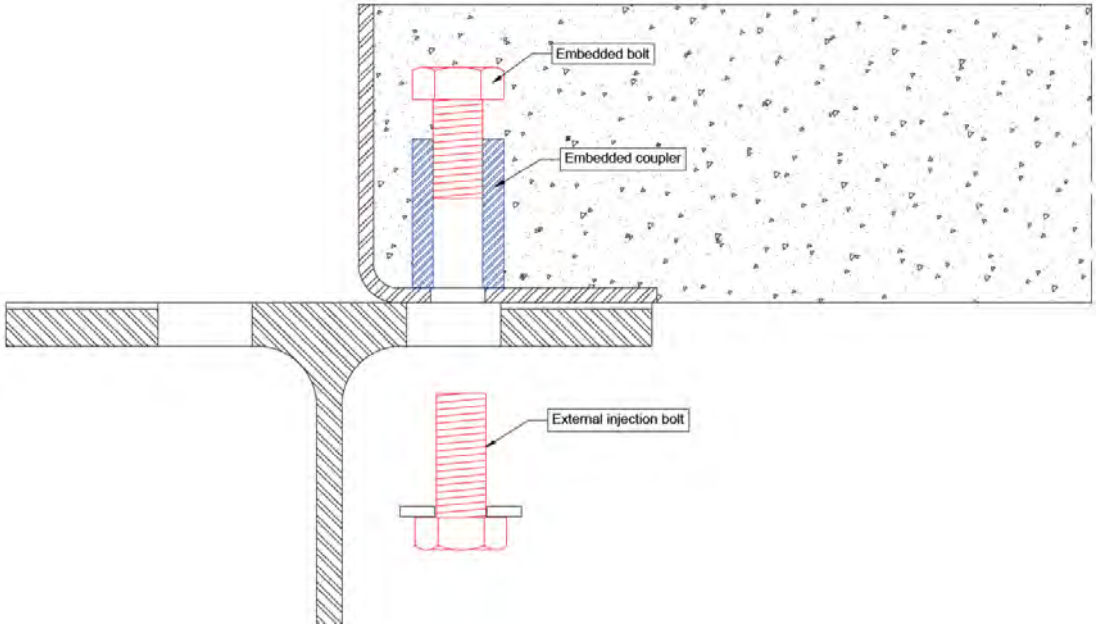
Cast in-situ demountable decks

Prefabricated demountable decks



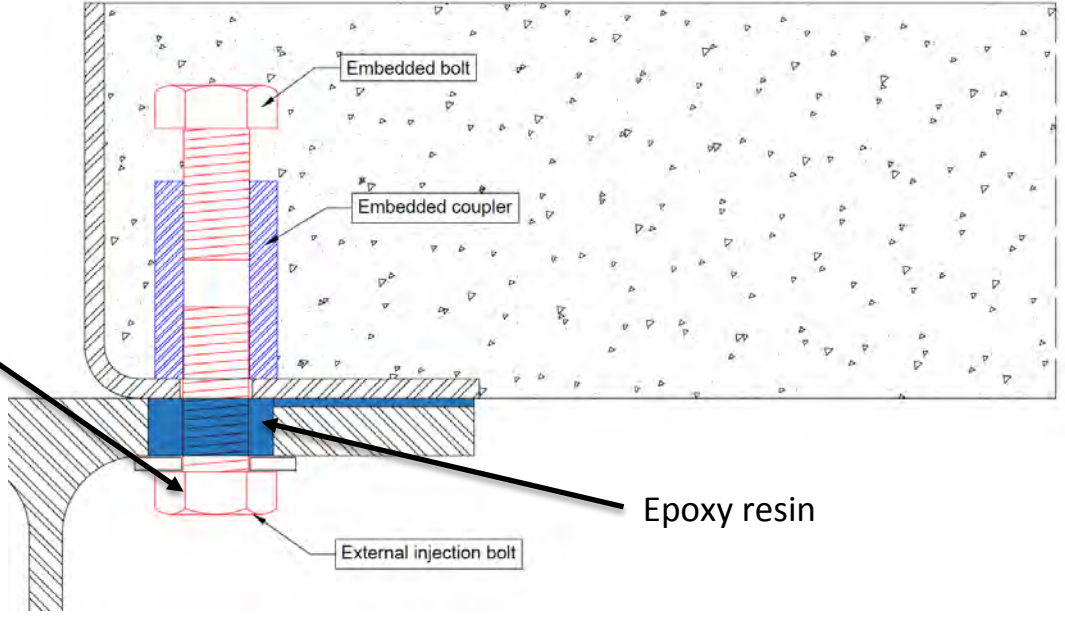
Installation of prefab. demountable decks

- Oversize holes in beam flange
  - Execution and manufacturing tolerances



Installation of prefab. demountable decks

- Immediate composite action under live load
  - Injection of clearance with epoxy resin



Quantification of benefits of reuse

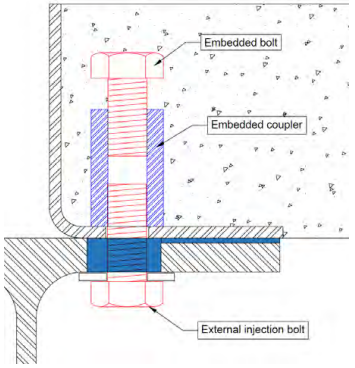
- Life-cycle assessment
  - Functional unit
  - Assessment protocol
  - Estimated Service Life (ESL)
- Building Information Modelling

Levels of scale in demountable structures

Small-scale
(Material)

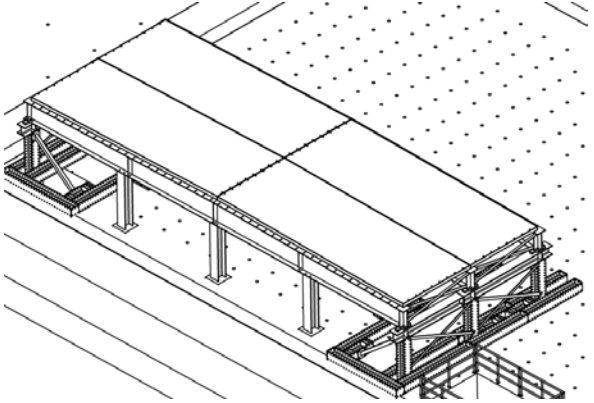
Material modelling

Medium-scale
(Component)



Mechanical properties of connectors

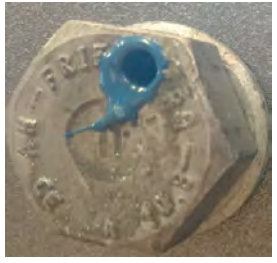
Full-scale
(Structure)



Structural performance + recommendations for practice

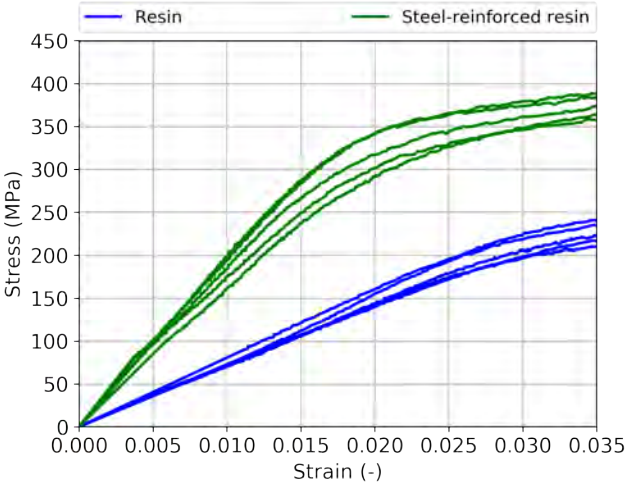
Epoxy resin – SW404 + HY2404

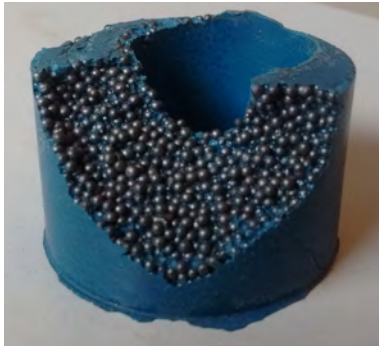
- Commercially available resin
- Frequently used in injected bolted steel-to-steel connections

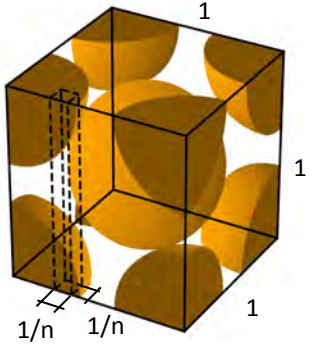


Epoxy resin – Improvement

- Steel-reinforced resin
  - Higher Young's Modulus
  - Smaller creep deformation
- Patented in 2017

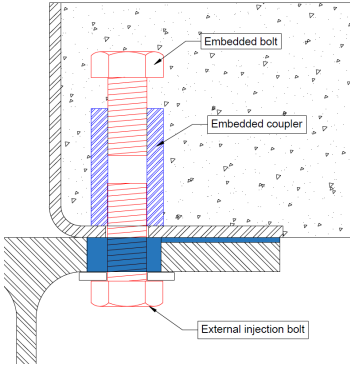


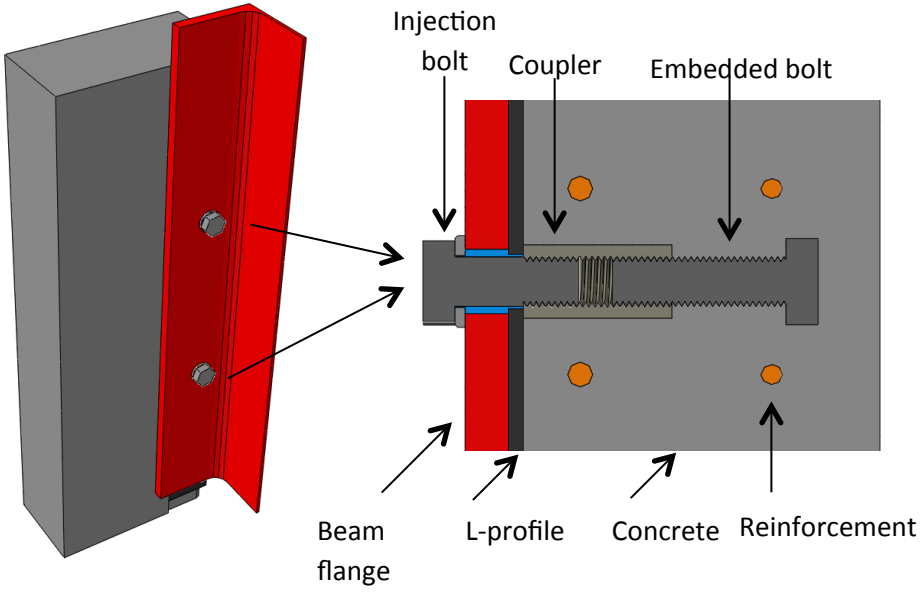


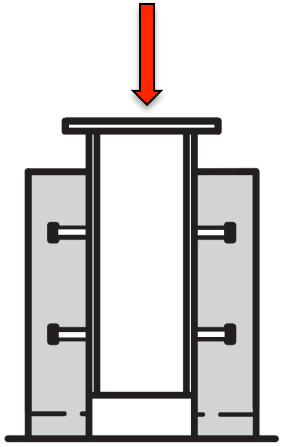


Mechanical behaviour of shear connector

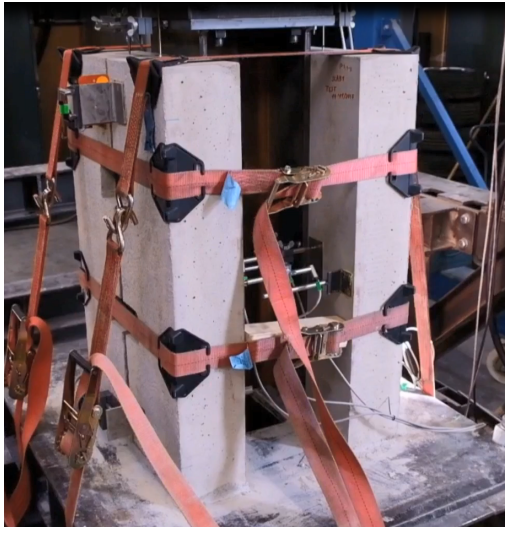
- Push-out test

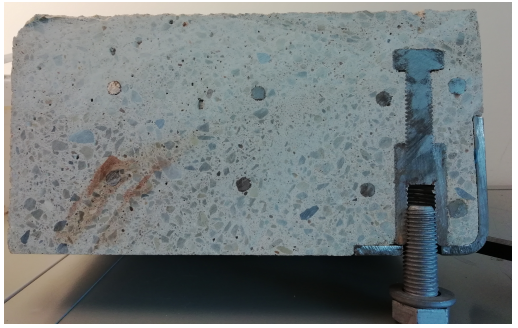


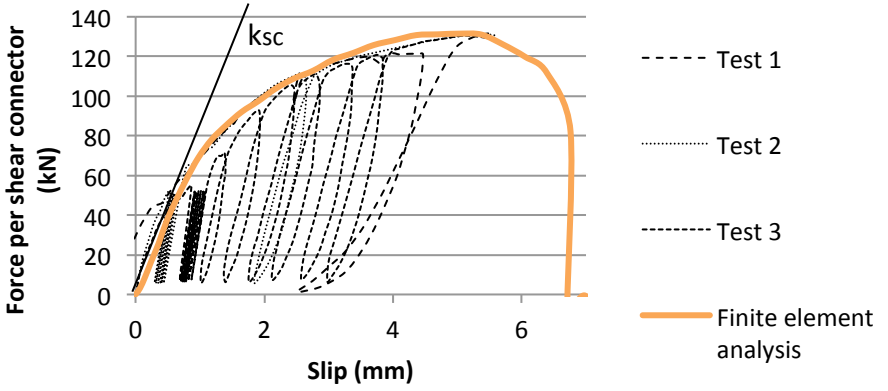




Mechanical behaviour of shear connector

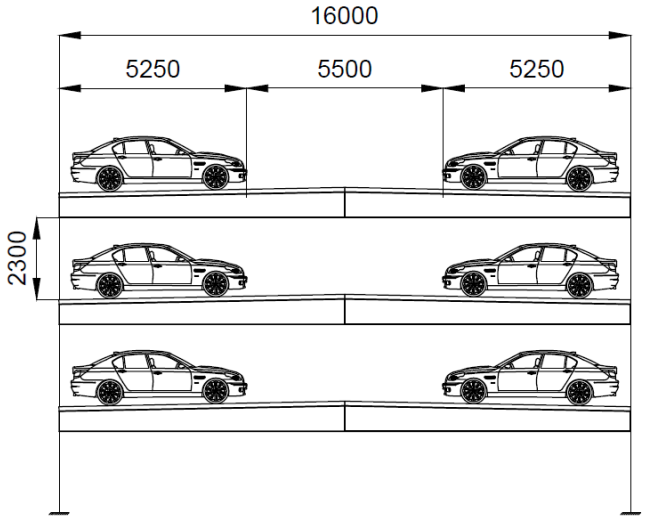


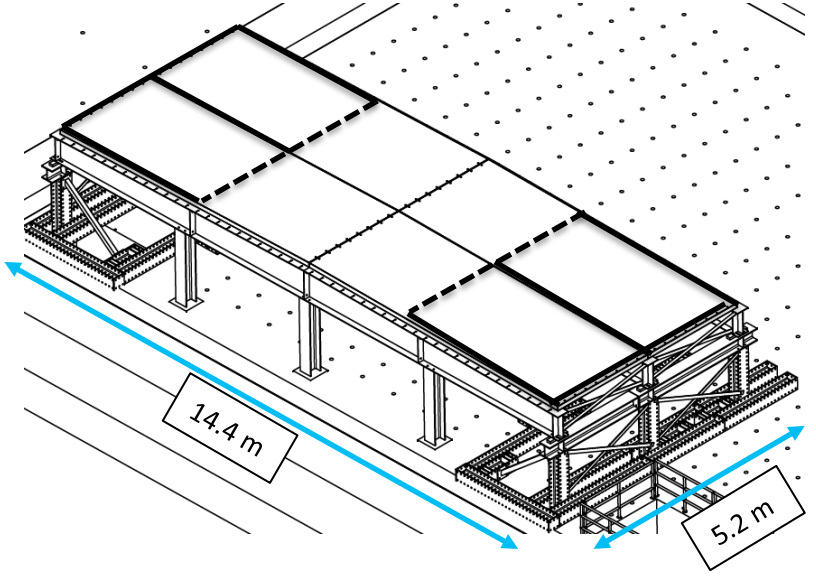




Mock-up of demountable building

- Multi-storey car park





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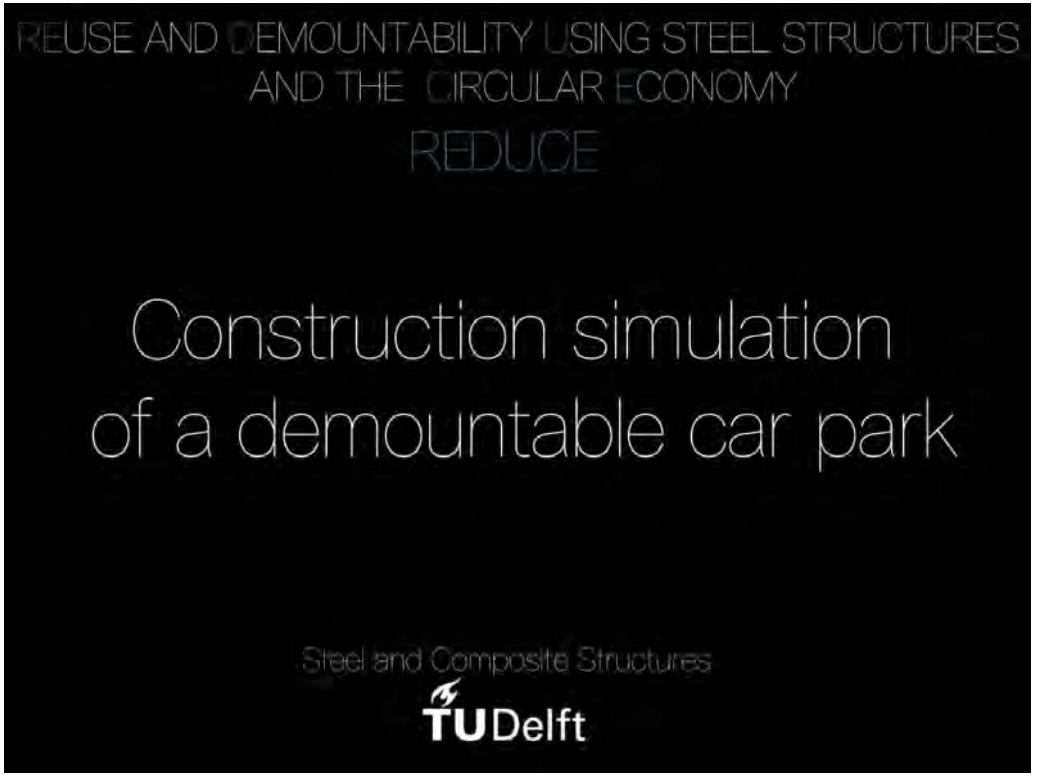
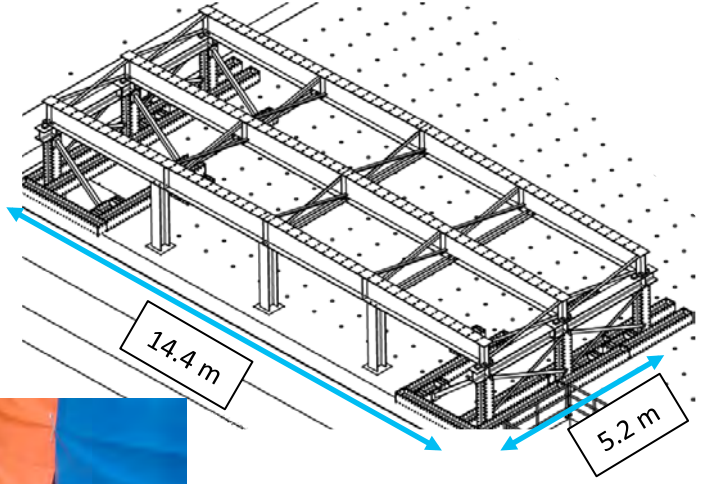
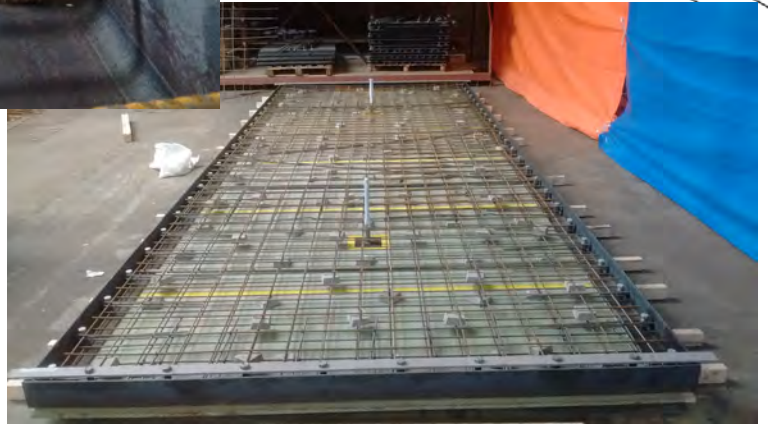
Animation of multi-storey car park building



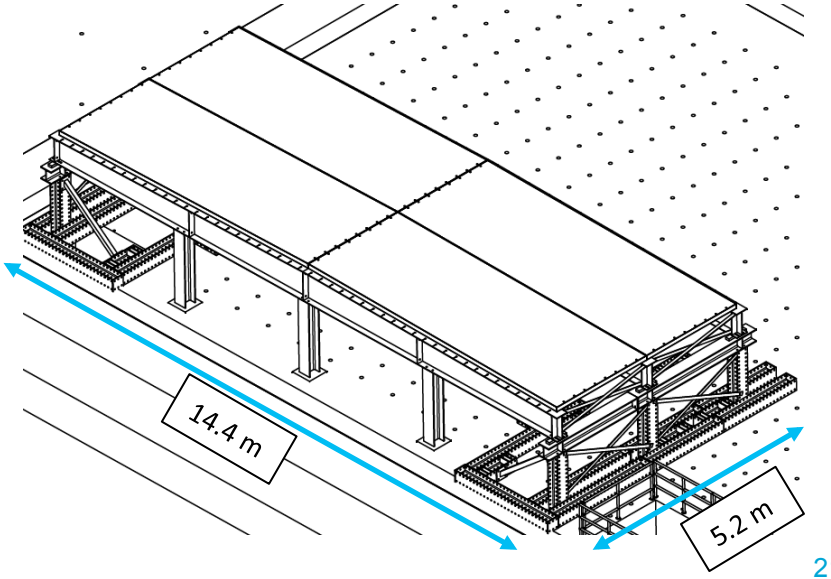
Mock-up of demountable building



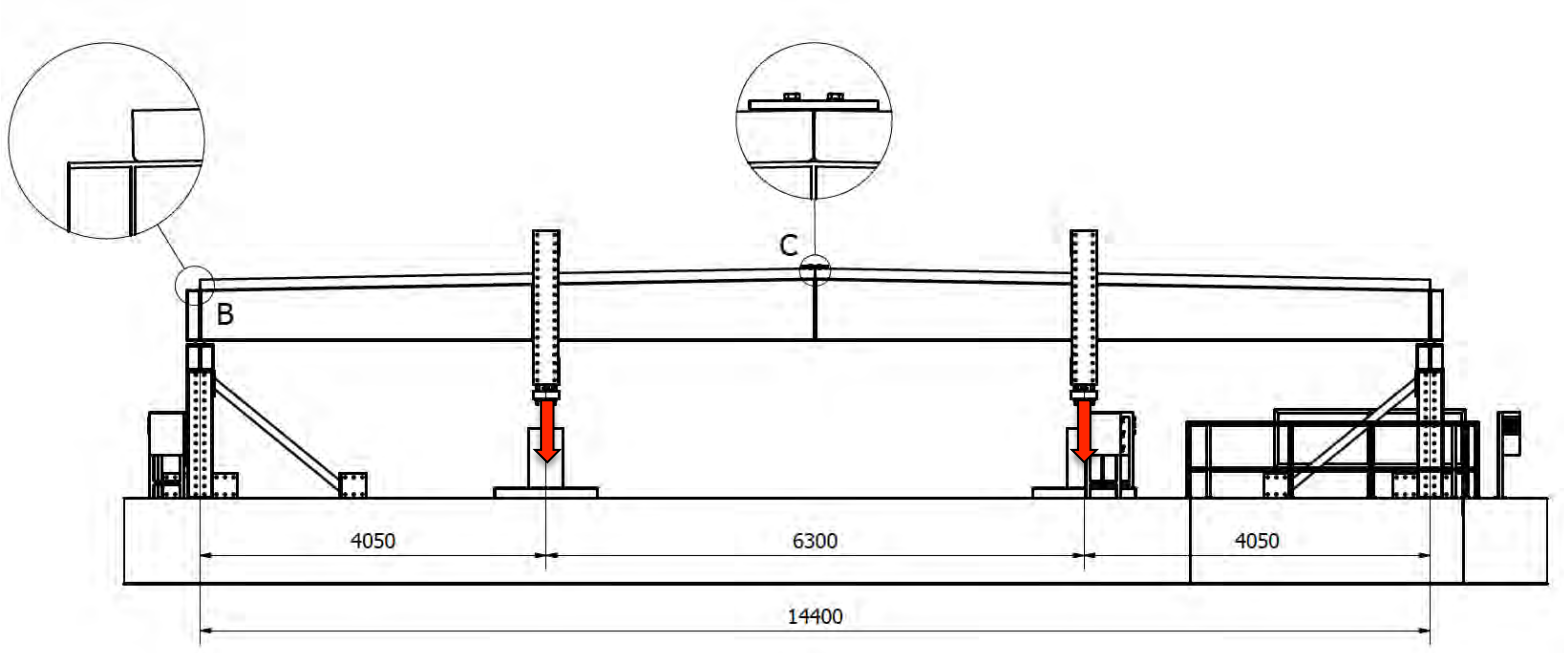


Demountable building – feasibility

- Required hole clearance
- Time and process measurements
  - Productivity
  - Costs
- Critical situations during execution/ demounting

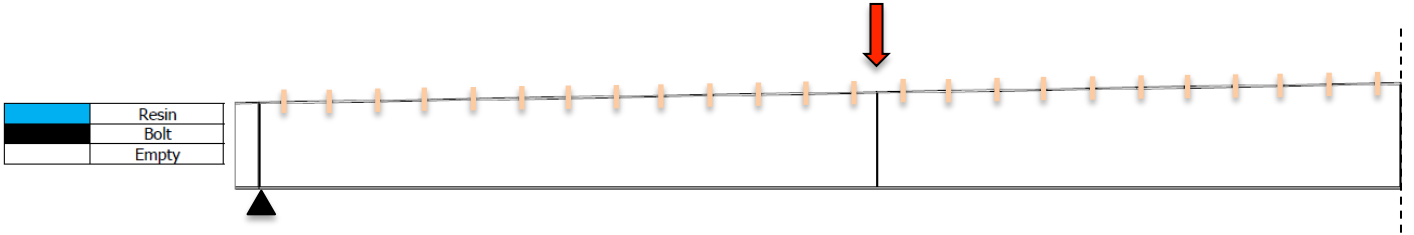


Demountable building – mechanical testing



Demountable building – testing objectives

- Various shear connector arrangements
  - Mechanical behaviour vs. costs



Arr. No.	Arrangement	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		300	600	900	1200	1500	1800	2100	2400	2700	3000	3300	3600	3900	4200	4500	4800	5100	5400	5700	6000	6300	6600	6900	7200
1	Steel frame																								
2	Frame+decks	■				■				■				■				■				■			■
6	U-6	■				■				■				■				■				■			■
3	S-6	■	■	■	■	■	■			■				■				■				■			■
4	S-9	■	■	■	■	■	■	■	■	■				■				■				■			■
7	U-12	■		■		■		■		■		■		■		■		■		■		■		■	
5	S-12	■	■	■	■	■	■	■	■	■	■	■	■					■				■			■
8	U-24	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Outlook – Demountable Composite Structures

2017-2018
- Research on various scales is on-going

2018-2019
- Development of injection tool for steel-reinforced resin for commercial applications

2019-2021
- Design recommendations and assessment tools for demountable composite structures

The buildings that we wish to reuse in the future, have to designed in the present

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Come and take a look

- Laboratory visit:

  18:05 – 19:15